THE END-TO-END SERVICE SYSTEM ARCHITECTURE FOR DEEP SPACE MISSIONS
(Track #5 Data System Engineering and Architecture)

Wallace S. Tai, System Engineering Manager
Telecommunications and Mission Operations Directorate
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91109
Mail 303-402, Phone (818) 354-7561, FAX (818) 393-1692, e-mail: wallace.s.tai@jpl.nasa.gov

ABSTRACT

As JPL moves into an era of flying more missions at much lower cost and shorter development duration, the Service System Architecture which includes the present Deep Space Network (DSN) and Advanced Multi-Mission Operations System (AMMOS) at JPL, has been redesigned to meet new challenges in providing services to approximately 35 missions during the next 5 years. Fundamental to this new architecture are services paradigm, end-to-end services, "unattended" DSN station operations, and Web-based mission operations system. The services paradigm, analogous to the operating approach of the utility company, is applied to formalize the service-subscriber, service-provider relationship. It simplifies the mechanism of subscriber's interface for services through the implementation of the concept of "service request" and its associated elements. This includes the development of a Mission and Assets Data Base (MADB) encompassing all the information about each subscribing mission, i.e., mission profile, service needs, telecommunication characteristics, trajectory, instances of service request, schedules and their linkage to characteristics of physical assets associated with the services. Key attributes of "standard services" have been elaborated. The specific services have been categorized into seventeen service families and one or more service types for each family. Functional description of these service types has been documented in a Services Catalog as the basis for establishing the service agreement between flight mission and service provider. The Service System Architecture is also defined in a layered view where the various service types fit in as the primary building blocks at different layers of the architecture. An important new concept is that the service system is end-to-end in nature, i.e., encompassing both flight and ground systems. This enables standard services which contain both flight and ground components to be "pre-fabricated", integrated and tested in order to support subscribers' need even at the very beginning of the development phase of any flight mission. To that end, the Spacecraft Transponding Modem (STM), a new generation of low-power, low-mass, highly-miniaturized deep space transponder, has been designed to include service components fully in complement with their ground counterparts. Another purpose of the end-to-end service design is to facilitate the migration of certain autonomy functions between flight and ground through common implementation. These include device control, auto-planning, auto-navigation, resource management, spacecraft engineering analysis and monitoring, etc. To minimize the service costs, a feature of the Service System Architecture is the "unattended" DSN station operations based on the Deep Space-Terminal (DS-T) design which is similar to that of Low Earth Orbit-Terminal (LEO-T) proved by an operational unit at JPL. The DS-T design represents a fundamental departure from the current DSN architecture since in this design each DSN antenna, treated as independent operating entity, embodies its own tracking, telemetry, and command elements. The direct effect is a highly simplified operational environment enabling automated service execution by its physical assets. Complementing the unattended DS-T design is the Web-based mission operations system (MOS) which applies a client-server model using JAVA technology to accommodate geographically distributed flight teams. Multi-mission operations services and tools, accessible to subscribers via Internet, thus provides a virtual MOS at the finger tips of each investigator and flight engineer without requiring collocated teams.